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Orthocone Cephalopods as Paleocurrent Indicators in the Ordovician Kimmswick Formation of Northeastern Missouri

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ORTHOCONE CEPHALOPODS AS PALEOCURRENT INDICATORS IN THE ORDOVICIAN KIMMSWICK FORMATION OF NORTHEASTERN MISSOURI

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ABSTRACT

The intent of this project is to map and analyze orientations of large orthocone cephalopods in the Late Ordovician Kimmswick Formation to determine whether they indicate traceable current directions. The Kimmswick Formation is a medium-to-coarsely-grained crystalline limestone which is highly fossiliferous, with bedding varying from massive to cross-bedded, and ranging from 10-30 meters in thickness in the project region. Numerous orthocone cephalopods (of the genera Endoceras and Cameroceras) can be observed within the lower Kimmswick in several locations in Northeastern Missouri, especially near Imperial and Frankford. A total of 21 orientations along a six-kilometer corridor near Imperial have been collected to date. While not a sufficient sample for statistically significant analysis, these measurements, taken together with other field observations, indicate a bimodal distribution of orientations at this locality (with similar patterns observed at other localities). In addition, the orthocones show a consistent preference for generally easterward apical alignment. Nearly all of these measurements have been collected from a single massive bed, herein titled the Kimmswick Nautiloid Bed (KNB), which can be correlated across outcrops against the underlying shaley House Springs K-Bentonite Bed. While cephalopods are known in the Kimmswick faunal lists, they are not common; they appear to be restricted to specific beds, such as the KNB; and their orientations have hitherto not been analyzed. The Kimmswick Formation is conventionally understood to represent a carbonate platform, with a relatively calm depositional environment. Preferential orientation of orthocone fossils may be indicative of a more energetic depositional environment for the Kimmswick than commonly supposed. More research is needed to accumulate a larger set of orthocone orientations, to study the grading of other fossil debris within the KNB, and to establish stratigraphical correlation of the KNB with the cephalopod-bearing Kimmswick bed in Frankford and other more distant localities.

KEYWORDS

nautiloid, kimmswick, orientation, paleocurrent, orthocone, cephalopod, ordovician, depositional environment

THE AUTHOR

Zachary Klein is a software architect, independent researcher, and homeschooling father. He has long had a deep interest in the Earth sciences, and has authored and led geological field trips in the St Louis, Missouri region as well as other locations, and regularly engages in field research and interacts with the local geology/paleontology community. He serves as a creation speaker and as a member of the Board of the Missouri Association for Creation, and enjoys introducing people to the grandeur of God's creation and the reliability of Scripture.

Preferential Orientation of Nautiloid Fossils: Evidence for Rapid Limestone in Northeastern Missouri

Orthocone Cephalopods as Current Indicators *in the Ordovician Kimmswick Formation in Northeastern Missouri*

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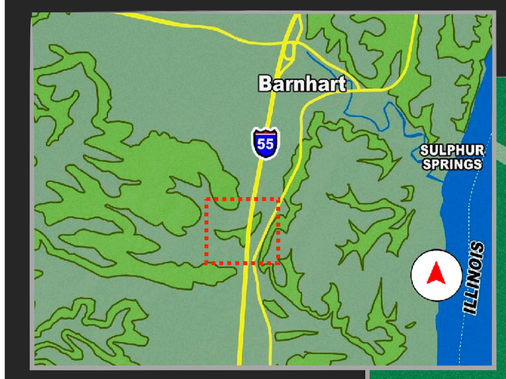
ABSTRACT: The intent of this project is to map and analyze orientations of large orthocone cephalopods in the Late Ordovician Kimmswick Formation to determine whether they indicate traceable current directions. The Kimmswick Formation is a medium-to-coarsely-grained crystalline limestone which is highly fossiliferous, with bedding varying from massive to cross-bedded, and ranging from 10-30 meters in thickness in the project region. Numerous orthocone cephalopods (of the genera Endoceras and Cameroceras) can be observed within the lower Kimmswick in several locations in Northeastern Missouri, especially near Imperial and Frankford. A total of 21 orientations along a six-kilometer corridor near Imperial have been collected to date. While not a sufficient sample for statistically significant analysis, these measurements, taken together with other field observations, indicate a bimodal distribution of orientations at this locality (with similar patterns observed at other localities). In addition, the orthocones exhibit predominantly Eastward apical alignment. Nearly all these measurements have been collected from a single massive bed, herein titled the Kimmswick Nautiloid Bed (KNB), which can be correlated across outcrops against the underlying shaley House Springs K-Bentonite Bed. While cephalopods are known in the Kimmswick faunal lists, they are not common; they appear to be restricted to specific beds, such as the KNB; and their orientations have hitherto not been analyzed. The Kimmswick Formation is conventionally understood to represent a carbonate platform, with a relatively calm depositional environment. Preferential orientation of orthocone fossils may be indicative of a more energetic depositional environment for the Kimmswick than commonly supposed. More research is needed to accumulate a larger set of orthocone orientations, to study the grading of other fossil debris within the KNB, and to establish stratigraphical correlation of the KNB with the cephalopod-bearing Kimmswick bed in Frankford and other more distant localities.

SCAN ME

Take a picture to download the **poster!**



Preferential Orientation: Evidence of Fast-Flowing Currents?

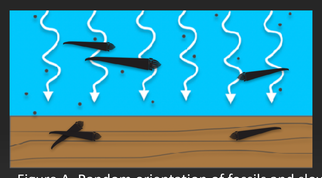


Figure A. Random orientation of fossils and slow deposition of mud particles in calm water.

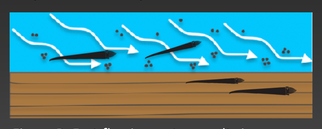


Figure B. Fast-flowing water results in preferential orientation of fossils and rapid deposition of mud particles as floccules.

Field observations and laboratory experiments have demonstrated that orthocone nautiloid fossils exhibit certain patterns of orientation when deposited in a unidirectional current (depending on certain factors such as the size and density of the animal in the current). Many of the the fossils will be oriented with their apical ends pointed upstream, while some will assume an orientation perpendicular to the current. This is consistent with the orientations measured in the **Kimmswick Nautiloid Bed,** here plotted in a rose diagram (Figure C).

This quadripolar distribution of orientations, as well as the concentration of specimens in a single bed, may indicate that the nautiloids were caught up in a strong current when they were buried (Figure B), and not randomly distributed in calm waters (Figure A) or in a bi-directional current (such as wave action on a beach).

Similar distribution patterns have been observed (at a much larger scale) in the Grand Canyon, where Dr. Steve Austin has documented the existence of a mass kill (> 1 billion) of nautiloids in a persistent massive bed of the Redwall Limestone.

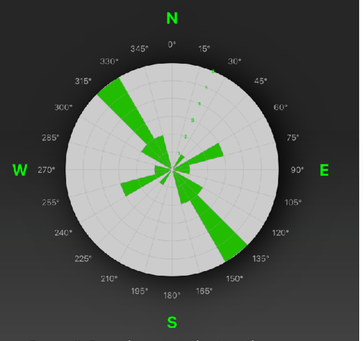


Figure C. Rose diagram indicating the orientation of 16 nautiloids from the I55 locality.

Orthocone Nautiloids of the Kimmswick Nautiloid Bed

The nautiloid genera known in the Kimmswick Formation include *Endoceras* and *Cameroceras*. Both exhibit a typical orthocone morphology, with some minor differences in the position of the siphuncle (living chamber) relative to the outer shell. Distinguishing the two genera in the field is not always feasible, but the study area appears to predominantly feature *Cameroceras*.

L: Location; D: Diameter; O: Orientation

1 L: 38.330063, -90.400567
D: 1.5"; O: 74°E

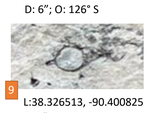
2 L: 38.328942, -90.400772
D: 6"; O: 40°NE

3 L: 38.328450, -90.400878
D: 7"; O: 74° E

4 L: 38.328412, -90.400872
D: 6"; O: 130° SE

5 L: 38.327697, -90.400887
D: 5"; O: 155° SSE

8 L:38.327580, -90.400833
D: 6"; O: 126° S



9 L:38.326513, -90.400825
D: 2"; O: 74° E

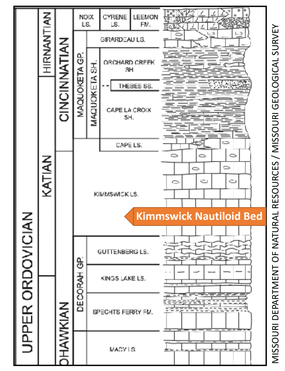
11 L:38.327042, -90.401642
D: 3"; O: 90° E

11 L:38.326513, -90.400825
D: 2"; O: 74° E

12 L:38.326513, -90.400825
D: 6" O: 142° SE

13 L:38.326513, -90.400825
D: 4"; O: 140° SE

Kimmswick Formation



The Kimmswick Formation is a course crystalline limestone that extends across Arkansas, Illinois, and Missouri. It is most often exposed along the Mississippi River, and is variously marked by unconformity/ paraconformity between the underlying Decorah Group and overlying Cape Limestone. The Kimmswick is very fossiliferous, and its most distinctive fossils are the algal *Receptaculites oweni* (aka "Sunflower Coral"). Cephalopod fossils are known in the Kimmswick, but are not often observed in the formation. The singular "Kimmswick Nautiloid Bed" accounts for 90% of orthocones observed in this research.

House Springs K-Bentonite

The Kimmswick Nautiloid Bed can be identified as a massive bed of crystalline limestone that directly overlies the shaley House Springs K-Bentonite. Ordovician Bentonites are understood to be massive volcanic ash deposits erupted as part of the Taconic Orogeny on the East Coast of Laurentia (North America). They serve as important markers for dating and stratigraphic correlation.

Extent of Ordovician K-Bentonites. After Kolata et al, 1986

Further Findings

A total of 21 orthocone orientations have been collected from locations near Imperial MO. In Spring of 2023, this research has expanded to Frankford MO, over 100 miles Northwest of the original KNB site. Preferential orientation of nautiloids has been observed here, as well as a shaley/ clay layer that may correlate to the House Springs K-Bentonite Bed. This research is ongoing.